Claims

I claim:

1. A composite coupling for use in assembling a restrained joint between a plurality of pipes having pipe ends and external complementary restraining grooves axially spaced from the pipe ends, the composite coupling comprising:

a cylindrical composite body, the cylindrical composite body defining an axis and having a first end, a second end, an exterior surface and an interior surface;

a first retainer groove in the interior of the coupling, the first retainer groove being axially spaced from the first end;

a first port, the first port communicating between the exterior surface and the first retainer groove;

a second retainer groove in the interior of the coupling, the second retainer groove being axially spaced from the second end;

a second port, the second port communicating between the exterior surface and the second retainer groove; and

wherein the cylindrical composite body comprises a plurality of concentrically arranged layers of wound filaments in a thermoset plastic matrix, each of the

layers characterized by a winding angle opposing the winding angle of the adjoining layers.

2. The composite coupling of claim 1 and wherein the coupling further comprises:

means for sealing the pipes in a restrained joint to maintain a pressurized flow between the pipes through the restrained joint.

3. The composite coupling of claim 2 and wherein the means for sealing the pipes includes providing a seal between each pipe and the interior surface of the coupling.

4. The composite coupling of claim 3 and wherein the means for sealing between each pipe and the interior of the coupling includes interposing an O-ring between each pipe and the interior surface of the coupling.

5 The composite coupling of claim 4 and wherein the O-rings are carried in O-ring grooves at the interior surface.

6. The composite coupling of claim 1 and further comprising:

means to index a first pipe end so as to position a first complementary retainer groove coincident with the first retainer groove.

7. The composite coupling of claim 6 and further comprising:

means to index a second pipe end so as to position a second complementary retainer groove coincident with the second retainer groove.

8. The composite coupling of claim 7 and wherein the means to index the first complementary retainer groove with the first retainer groove is a pipe stop, the pipe stop limiting the depth of insertion of the first pipe into the first end of the composite coupling.

9. The composite coupling of claim 7 and wherein the means to index the second complementary retainer groove with the second retainer groove is a pipe stop, the pipe stop limiting the depth of insertion of the second pipe into the second end of the composite coupling.

10. The composite coupling of claim 9 and wherein the pipe stop is a protrusion extending radially inward from the interior surface of the coupling body.

11. The composite coupling of claim 10 and wherein the pipe stop is symmetric about the axis and is a unitary part of the cylindrical composite body.

12. The composite coupling of claim 11 and wherein the pipe stop is a cylindrical segment with a first end and a second end and substantially the same cross-section as the pipe to be joined, situated within the interior surface, such that the first end of the cylindrical segment abuts the end of a first pipe when situated with the complementary retainer groove coincident with the first retainer groove and the second end of the cylindrical segment the end of the second pipe when the complementary retainer groove of the second pipe is coincident with the second retainer groove.

13. The composite coupling of claim 1 and wherein the first port is cylindrical bore extending between the exterior surface and the first retainer groove.

14. The composite coupling of claim 1 and wherein the first port is tangential to the first retainer groove.

15. The composite coupling of claim 1 and wherein the retainer grooves are circumferentially arranged about the axis of the cylinder.

16. The composite coupling of claim 1 and wherein the retainer grooves are characterized by a longitudinal cross-section of rectangular shape.

17. The composite coupling of claim 14 and wherein the first port initiates a pathway into the first retainer groove, the initiated pathway selected from the group

consisting of circumferential and helical and selected from the group consisting of clockwise and counter-clockwise for one viewing the pathway from the first end.

18. The composite coupling of claim 1 and wherein the filaments in a first layer of the composite are disposed upon a winding angle of about +55 degrees relative to the cylindrical axis.

19. The composite coupling of claim 18 and wherein the filaments in a second layer wound over the first layer are disposed upon a winding angle of about -55 degrees relative to the cylindrical axis.

20. The composite coupling of claim 19 and wherein the filaments in a third layer, wound over the second layer are disposed upon a winding angle of about +55 degrees relative to the cylindrical axis.

21. The composite coupling of claim 1 and wherein the winding angle is from 40 degrees to 65 degrees and the opposing winding angle is from -40 degrees to -65 degrees.

22. The composite coupling of claim 1 and wherein the pipes to be coupled have an outer diameter of about 16 inches.

23 The composite coupling of claim 1 and wherein the coupling has at least five layers of opposing windings.

24. The composite coupling of claim 23 and wherein the coupling has seven or more layers of opposing windings.

25. The composite coupling of claim 23 and wherein the coupling has ten layers of opposing windings.

26. The composite coupling of claim 1 and wherein the filaments are glass filaments.

27. The composite coupling of claim 26 and wherein the glass filaments are E-glass roving.

28. The composite coupling of claim 1 and wherein the thermoset matrix is epoxy.

29. The composite coupling of claim 6 and wherein the means for indexing is a snap ring.

30. The composite coupling of claim 29 and wherein the snap ring is bonded to the interior surface.

31. The composite coupling of claim 30 and wherein the snap ring has a gap.

32. The composite coupling of claim 1 and wherein the coupling is reversible.

33. A receiver useful for forming a restrained connection to a pipe having a pipe end and a complementary retainer groove spaced from the pipe end, the complementary retainer groove adapted for receiving a portion of a flexible spline, the receiver comprising:

a tubular body of composite material, the tubular body having at least one end, an interior and an exterior, and defining a longitudinal receiver axis;

an O-ring groove in the interior, the O-ring groove spaced axially from the at least one end;

a retainer groove in the interior between the at least one end and the O-ring groove;

a port communicating between the retainer groove and the exterior; and,

wherein the composite material includes a plurality of layers of wound filament in a thermoset plastic matrix, and wherein successive layers of the plurality of layers have alternating winding angles.

34. The receiver of claim 33 and wherein the receiver leads to a vessel.

35. The receiver of claim 34 and wherein the vessel includes another receiver.

36. The receiver of claim 35 and wherein the another receiver is identical to the receiver.

37. A restrained joint, the restrained joint comprising:

a first pipe having a pipe end and an external complementary retaining groove axially spaced from the pipe end of the first pipe;

a second pipe having a pipe end and an external complementary retaining groove axially spaced from the pipe end of the second pipe;

a wound-filament coupling including:

a cylindrical composite body, the cylindrical composite body defining an axis and having a first end, a second end, an exterior surface and an interior surface;

a first retainer groove in the interior of the coupling, the first retainer groove being axially spaced from the first end;

a first port, the first port communicating between the exterior surface and the first retainer groove;

a second retainer groove in the interior of the coupling, the second retainer groove being axially spaced from the second end;

a second port, the second port communicating between the exterior surface and the second retainer groove; and

wherein the cylindrical composite body comprises a plurality of concentrically arranged layers of wound filaments in a thermoset plastic matrix, each of the layers characterized by a winding angle opposing the winding angle of the adjoining layers;

a first flexible spline; the first flexible spline encircling at least an arc of the first pipe and being inserted into at least a portion of the complementary retainer groove of the first pipe and the first retainer groove of the coupling, so as to axially lock the first pipe end within the first end of the coupling; and,

a second flexible spline; the second flexible spline encircling at least an arc of the second pipe and being inserted into at least a portion of the complementary retainer groove of the second pipe and the second retainer groove of the coupling, so as to axially lock the second pipe end within the second end of the coupling.

38. The restrained joint of claim 37 and wherein the first pipe and the second pipe are sealed to the interior of the coupling.

39. The restrained joint of claim 38 and wherein the first pipe and the second pipe are sealed to the interior of the coupling by O-rings.

40. The restrained joint of claim 39 and wherein the O-rings are located between the first and second retaining grooves of the coupling.

41. The restrained joint of claim 40 and wherein the coupling further includes: means for indexing the first and second pipes such that the complementary retaining grooves of the first and second pipes are limited in insertion to coincident relationships with the first and second retaining grooves of the coupling.

42. The restrained joint of claim 41 and wherein the means for indexing includes a snap ring.

43. The restrained joint of claim 41 and wherein the means for indexing includes a unitary protrusion directed radially inward within the coupling.

44. A restrained connection comprising:

a first pipe having a pipe end and an external complementary retaining groove axially spaced from the pipe end of the first pipe;

a wound-filament receiver including:

a cylindrical composite body, the cylindrical composite body defining an axis and having a first end, an exterior surface and an interior surface;

a first retainer groove in the interior of the receiver, the first retainer groove being axially spaced from the first end;

a first port, the first port communicating between the exterior surface and the first retainer groove;

wherein the cylindrical composite body comprises a plurality of concentrically arranged layers of wound filaments in a thermoset plastic matrix, each of the layers characterized by a winding angle opposing the winding angle of the adjoining layers; and

a first flexible spline; the first flexible spline encircling at least an arc of the first pipe and being inserted into at least a portion of the complementary retainer groove of the first

pipe and the first retainer groove of the receiver, so as to axially lock the first pipe end within the first end of the receiver.

45. A method of making a filament-wound composite article, the article selected from the group consisting of couplings and receivers, comprising the steps of:

winding a resin wetted filament upon a mandrel at a pre-determined winding angle to form a first angled winding layer;

winding a resin wetted filament upon the first angled winding layer to form a second angled winding layer, the second angled winding layer being an opposed angle relative to the first layer;

winding a successive resin wetted filament upon the second layer to form a third angled winding layer, the third angled winding layer being an opposed angle relative to the second layer;

segmenting the resulting layered wound product to obtain a cylindrical body;

machining the cylindrical body to provide at least one internal retaining groove;

drilling a port to the at least one retaining groove to provide communication with an exterior surface of the cylindrical body.

46. The method of claim 45 and wherein the resin is at least partially cured prior to segmenting.

47. The method of claim 45 and wherein the retaining groove is one of at least a pair of retaining grooves and the port is one of at least a pair of ports, each of the ports associated with one of the retaining grooves.

48. The method of claim 45 and further comprising the steps of:

providing an index for limiting pipe insertion wherein the index is selected from the group of a snap ring and a machined unitary; and,

inserting the snap ring to provide an index for limiting pipe insertion.

49. The method of claim 48 and further comprising the step of:

machining a receiver groove for the snap ring.

50. The method of claim 45 and further comprising the step of:

machining an index within the cylindrical body to limit pipe insertion.

51. The method of claim 45 and further comprising the steps of:

machining at least one O-ring groove; and

inserting an O-ring in the O-ring groove.

52. A method of assembling a restrained joint comprising the steps of:

providing a filament-wound composite coupling having a first end with a first retaining groove and a first port communicating with the first retaining groove, and a second end with a second retaining groove and a second port communicating with the second retaining groove;

providing a first pipe with a first complementary retaining groove and a second pipe with a second complementary retaining groove;

providing a first flexible spline and a second flexible spline;

inserting the first pipe into the first end such that the first complementary retaining groove of the first pipe is coincident with the first retaining groove and subsequently inserting the first flexible spline through the first port and into at least a portion of the coincident first complementary retaining groove and first retaining groove so as to axially lock the first pipe to the coupling; and,

inserting the second pipe into the second end such that the second complementary retaining groove of the second pipe is coincident with the second retaining groove and subsequently inserting the second flexible spline through the second port and into at least a portion of the coincident second complementary retaining groove and second retaining

groove so as to axially lock the second pipe to the coupling, thereby assembling a restrained joint.

53. The method of claim 52 and wherein the filament–wound composite coupling is symmetrical and reversible.

54. The method of claim 52 and wherein the filament–wound composite coupling further includes O-rings to seal the first and second pipes to the coupling.

55. The method of claim 52 and wherein the coupling further includes means for indexing the first and second pipes to facilitate establishing coincident relationships for the complementary retaining grooves relative to the retaining grooves of the coupling.

56. The method of claim 53 and wherein the ports direct the splines in a clockwise orientation relative an ends of the coupling.

57. A pipe system comprising:

a plurality of pipes, each of the pipes of the plurality having two ends and an outward directed complementary retainer groove associated with each end;

at least one filament-wound composite coupling, the coupling including two ends, two inwardly directed retaining grooves, each of the retaining grooves having a port communicating with the retaining groove;

at least two flexible splines, each spline being insertable into one of the retaining grooves through the associated port to axially lock a pipe end to the coupling by retaining a coincident relationship between the complementary retaining groove and the retraining groove, thereby defining a restrained joint of the pipe system.

58. The pipe system of claim 57 and wherein the pipe system is a water distribution pipe system and the system includes a plurality of restrained joints, and a plurality of pipes participating in a restrained joint on each end of the pipe.

59. The pipe system of claim 58 and wherein the retrained joints further include O-ring seals between the pipe and the coupling and further wherein the pipes are PVC pipes.

60. A method of directional drilling comprising the steps of:

providing a plurality of pipes, each of the pipes of the plurality having two ends and an outward directed complementary retainer groove associated with each end;

providing at least one filament-wound composite coupling, the coupling including two ends, two inwardly directed retaining grooves, each of the retaining grooves having a port communicating with the retaining groove;

providing at least two flexible splines, each spline being insertable into one of the retaining grooves through the associated port to axially lock a pipe end to the coupling by retaining a coincident relationship between the complementary retaining groove and the retraining groove; and,

assembling a restrained joint between two pipes using the at least one filament–wound composite coupling and the at least two flexible splines; and

pulling one of the pipes through the earth so as to pull the retrained joint and the other pipe through the earth.

61. The method of directional drilling of claim 60 and further comprising:

assembling another restrained joint using another pipe and another filament-wound composite coupling to the remaining end of the other pipe so as to pull the another restrained joint and another pipe through the earth.